

December 2, 2002

Brotherhood Mutual Insurance Company
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Attention: Michael Allison, JD, CPCU

Re: ROLLOVER HAZARDS ASSOCIATED WITH OPERATIONAL
SAFETY PROBLEMS OF 15 PASSENGER VANS

To: Operators of 15 passenger vans

Summary: Operational data, results of test track accident avoidance maneuvers and engineering theory all point to a serious rollover stability problem with loaded 15 passenger vans. Specific re-design features have been recommended for vehicles of the future. Special restrictions are given, which are required for safe operation of existing vehicles.

Motor vehicle accident statistical studies have shown a greatly disproportionate amount of death and serious injury from single-vehicle rollover incidents. Over a period of several years, during which deaths from other passenger vehicles were declining, deaths involving 15 passenger vans and vehicles somewhat similar in certain respects rose, reflecting among other things greater usage. The somewhat similar vehicles included single-vehicle pickup truck rollover accidents. In addition, when two further aspects were factored in, a need became clear for restrictive operation of 15 passenger vans. These aspects were driver impairment and loading. Fatigue and blood alcohol level factored noticeably higher in the pickup truck than in the 15-passenger van driver involvement, demonstrating an obvious sociological difference. Correcting for lack of driver involvement statistically further pointed to the greater-than-10-passenger-loading problem in van accidents. Hence, the simplest, more efficacious and immediate (albeit stringent) way to mitigate the danger is to restrict the passenger loading to 10, none behind the rear axle, by removing the rear seat.

Other indicators were, commercial bus driver licenses are required for vehicle capacities of 16 or more; the 15 passenger van design was basically a stretched version of the 11 passenger van; and the engineering parameters for a loaded 15 passenger van point to increased handling problems.

The lack of experience of the average driver in the peculiarities of the 15 passenger van noted below should be countered by institutions designating certain drivers with good records who have made a commitment to learn and work with these peculiarities. Seat belt discipline is a must. The vans do not have to, and do not, pass certain Federal Motor Vehicle Safety Standards with respect to head rests, side impact strength, door opening resistance and roof crush strength. Furthermore, they roll over easier, during which event it is particularly important to be seat belted. A designated driver would be in a more secure position to insist on seat belt discipline.

The problems have been the subject of a research report*, a technical report** and safety recommendations*** by the National Highway Traffic Safety Administration.

Comparisons are made of the static stability factor (SSF) of a 15-passenger van, a 7-passenger van and a mini-van. In addition, the angular inertia of the vehicles is considered. The statistics and SSF are measures of rollover propensity in single-vehicle crashes: Comparing crashes of vans with fewer than and more than 10 occupants, there is in the latter almost three times the propensity to roll over. The SSF from lightly loaded to gross vehicle weight load decreases 11% with the Ford E-350, 5% with the Ford E-150 and 3% with the Dodge caravan (the E-350 loaded had 15 occupants, the other two, only 7). The height of the center of gravity increased 11%, 5%, and 4%. The conditions increased 38%, 15, and 27%, respectively. The moment of inertia in roll increased 29%, 11%, and 16%.

The increase in the moments of inertia are important in handling maneuvers. An analogy with respect to straight-line stopping distance capabilities would be a loaded versus unloaded train, truck or other vehicle. More momentum due to more mass to stop creates a problem, which is compensated normally by awareness; for example, a locomotive engineer using his dynamic and air brakes accordingly. Here, the larger amount of inertia in yaw makes the tail wag, harder to compensate. Both the simulations and the actual tests of the vans in the avoidance maneuver show a problem arises when the rear end skids out due to this effect, leading to rollover. With the larger roll moment of inertia, once the roll starts, it's harder to stop, and the vehicle often rolls several times. A future redesign solution would augment driver capability with electronic stability steering. The situation that arises is shown well in a "60 Minutes" interview wherein one of the survivors of such a crash said that the deceased driver was obviously doing her best. However, the van seemed to have a mind of its own (of 12 passengers, 4 were decedent). Restricting the van to 10 occupants, all forward of the rear axle, would decrease this tendency. Another recommended design improvement would fit 15-passenger vans with dual rear wheels.

To exemplify roll instabilities: With a Model T Ford, a driver could roll the car on its side in a parking lot by simply turning the wheel at low speeds. Same thing with 3-wheel golf carts and ATVs. If a driver were to go into emergency maneuver with a loaded truck, it will roll rather than slide. However, these trucks should be driven by experienced operators. (Three-wheel carts and ATVs are no longer made.) A Porche mid-engine sportster, at the other extreme, will go into a 4-wheel drift and won't roll over (unless tripped up on a curb, etc). Every regular passenger vehicle should be designed so that it will slide rather than roll. Trucks could not perform their function if they were so restricted. In addition, there is a sudden change from the normal understeer, which exists from most passenger vehicles to an oversteer situation, which is difficult to cope with. The problem here is that in a 15 passenger van, these criteria are not met, and must be compensated for.

CONCLUSIONS FOR THE OPERATORS OF THE PRESENT-GENERATION VAN

It's very important to remove the rear seat, restricting occupant load to 10, and avoid heavy objects being placed high up on the cargo; also, no roof cargo racks. The aforementioned use of designated drivers who have been acquainted with the problems involved, and will use their status to ensure seat belt usage.

Submitted by,



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* The Rollover Propensity of 15 Passenger Vans, April 2001

** Characteristics of Fatal Rollover Crashes, DOT 4 S 809438, April 2002

*** H-02-29, November 1, 2002. Other references utilized were *Motor Vehicle Accident Reconstruction and Cause Analysis*, Second Edition, Rudolph Limpert, professor of Mechanical Engineering, University of Utah. Mitchie Company. Copyright 1984. Especially chapter 22, "Vehicle Directional Control" pp 303-360, and its section 2.3 "Vehicle Rollover"; driver subjective evaluation in section 2.4. Also, *Accident Reconstruction*, James Collins, Charles C. Thomas; 1979; pp 242-246; "Rollover Accident". FMVSS noted & Federal Carrier Safety Regulations, part 391, "Qualification of Drivers".